

76 Rejected 21 MAR 1998

FORM PTO-1390 (REV 10-93)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				3210x198	
				U.S. APPLICATION NO (if known, see 37 CFR 1.5)	
PCT/EP96/03531		INTERNATIONAL FILING DATE		PRIORITY DATE CLAIMED	
		August 9, 1996		September 29, 1995	
TITLE OF INVENTION METHOD OF CARRYING OUT CONTINUOUS PREPARATION PROCESS ON TIGHTLY MESHING EXTRUDERS ROTATING IN THE SAME SENSE					
APPLICANT(S) FOR DO/EO/US PETER HEIDEMEYER et al.					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
<p>1 <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.</p> <p>2 <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.</p> <p>3 <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).</p> <p>4 <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</p> <p>5 <input type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))</p> <p>a. <input checked="" type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).</p> <p>b. <input type="checkbox"/> has been transmitted by the International Bureau.</p> <p>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</p> <p>6 <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).</p> <p>7 <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))</p> <p>a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).</p> <p>b. <input type="checkbox"/> have been transmitted by the International Bureau.</p> <p>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</p> <p>d. <input type="checkbox"/> have not been made and will not be made.</p> <p>8 <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</p> <p>9 <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</p> <p>10 <input checked="" type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</p> <p>Items 11. to 16. below concern document(s) or information included:</p> <p>11 <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</p> <p>12 <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</p> <p>13 <input checked="" type="checkbox"/> A FIRST preliminary amendment.</p> <p><input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.</p> <p>14 <input type="checkbox"/> A substitute specification.</p> <p>15 <input type="checkbox"/> A change of power of attorney and/or address letter.</p> <p>16 <input type="checkbox"/> Other items or information:</p>					

U.S. APPLICATION NO. (if known, see 37 CFR 1.51)		INTERNATIONAL APPLICATION NO. PCT/EP96/03531		ATTORNEY'S DOCKET NUMBER 3210x198	
17 <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO \$930.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) \$720.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) \$790.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$1070.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$98.00 <div style="text-align: right;">ENTER APPROPRIATE BASIC FEE AMOUNT =</div>				CALCULATIONS PTO USE ONLY	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input checked="" type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$ 1,070.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	8 - 20 =	- 0 -	X \$22.00	\$ -0-	
Independent claims	2 - 3 =	- 0 -	X \$82.00	\$ -0-	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+ \$270.00	\$
TOTAL OF ABOVE CALCULATIONS =				\$ 1,200.00	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				\$	
SUBTOTAL =				\$ 1,200.00	
Processing fee of \$130.00 for furnishing the English translation later than <input checked="" type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$ 130.00	
TOTAL NATIONAL FEE =				\$ 1,330.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				-	\$ 40.00
TOTAL FEES ENCLOSED =				\$ 1,370.00	
				Amount to be:	\$
				refunded	
				charged	\$
<p>a. <input checked="" type="checkbox"/> A check in the amount of \$ 1,370.00 to cover the above fees is enclosed.</p> <p>b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.</p> <p>c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 12-0064. A duplicate copy of this sheet is enclosed.</p>					
<p>NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</p>					
<div style="display: flex; justify-content: space-between;"> <div style="width: 60%;"> <p style="font-size: small;">SEND ALL CORRESPONDENCE TO</p> <p>Robert F. I. Conte</p> <p>LAFF, WHITESEL, CONTE & SARET, LTD.</p> <p>401 N. Michigan Ave. - Suite 1700</p> <p>Chicago, IL 60611-4212</p> </div> <div style="width: 35%; text-align: center;"> <p style="font-size: small;">SIGNATURE</p> <p>Robert F. I. Conte</p> <p style="font-size: small;">NAME</p> <p>20354</p> <p style="font-size: small;">REGISTRATION NUMBER</p> </div> </div>					

IN THE
UNITED STATES PATENT & TRADEMARK OFFICE

In Re Application of: Peter Heidemeyer et al.)
)
 Case No.: 3210x198) Group Art Unit:
)
 Serial No.:)
)
 Filed: herewith) Examiner:
)
 Title: METHOD OF CARRYING OUT)
 CONTINUOUS PREPARATION)
 PROCESS ON TIGHTLY MESHING)
 EXTRUDERS ROTATING IN)
 THE SAME SENSE)

Assistant Commissioner for Patents
 Washington, D.C. 20231

Dear Sir:

- [x] AUTHORIZATION TO PAY AND PETITION FOR THE ACCEPTANCE OF ANY NECESSARY FEES. If any charges or fees must be paid in connection with the following Communication (including but not limited to the payment of issue fees), they may be paid out of our deposit account No. 12-0064. If this payment also requires a Petition, please construe this authorization to pay as the necessary Petition which is required to accompany the payment.
- [] Applicant hereby petitions for entry of this Amendment which is mailed within the ___ month after the due date of _____. Enclosed is check No. _____, dated _____, in the amount of \$_____, as payment of the necessary Petition fee.

PRELIMINARY AMENDMENT

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first-class mail in an envelope addressed to Assistant Commissioner for Patents, Washington, D.C. 20231 on:

Date: March 27, 1998

By: _____

Signed: _____

LAFF, WHITESEL, CONTE & SARET, LTD
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Preliminary Amendment

1. In the specification

On page 4, last line, after "illustration", insert --and drawings--.

On page 5, line 5, insert

--Fig. 3 is a vertical cut over the length of an extruder,

Fig. 4 is a horizontal cut over the length of the extruder, and

Fig. 5 is a cross-section through the extruder along the line V-V of Fig. 3.--

On page 5, line 11, after "200 to 400 rpm", insert

--Details of these commercial machines will be explained below, based on Figs. 3 to 5.--

On page 9, after line 5, insert the following paragraph.

--The twin-screw extruders used for the tests specified above will become apparent from the diagrammatic illustration of Figs. 3 to 5. The housing 1 of the extruder comprises several housing sections 2, 3, 4, which have flanges 5 by which they are detachably joined to each other by means of screws 6. The housing 1 comprises two cylindrical housing bores 7, 8 which are parallel to each other, intersect each other and have axes 9, 10 parallel to each other. Screw shafts 11, 12 are disposed in the housing bores 7, 8, each having a shaft 13, 14 which constitutes the core of the respective screw shaft 11 and 12, respectively, and a screw 15, 16 which is disposed on the core, spiralling in the form of a thread. On each screw shaft 11, 12, a screw root 17, 18 is defined by each screw 15, 16, by the shaft 13, 14 and the housing bore 7, 8. There is only a small gap between the screw 15, 16 and the respective housing bore 7, 8.

As seen in Fig. 4, the two screws 15, 16 rotate in the same direction. As seen in Figs. 4 and 5, the screws 15, 16 mesh, i.e. the screw 16 of the screw shaft 12 engages with the screw root 17 of the screw shaft 11 and vice versa.

An inlet hopper 20, through which the materials to be processed are supplied, is formed on the housing section 2 which is disposed downstream, related to a direction of conveying 19. Outlet tools, namely die heads 21 such as pelletizing dies, die plates and the like may be attached to the housing section 4 which is disposed downstream, seen in the direction of conveying 10.

The screw shafts 11, 12 are each driven in the same direction of rotation 25 by a motor 22 via a clutch 23 and a reduction and distribution gear 24. Each shaft 13 and 14, respectively, can be driven by a torque M_d . The distance a of the axes 9, 10, the outer diameter D_a of each screw 15 and 16, respectively, and the screw inner diameter D_i are likewise seen in the drawing. D_a and D_i are identical for both screw shafts 11, 12.--

2. In the claims

Delete claims 2 to 5 without prejudice and insert the following claims 6 to 13.

6. A method of carrying out a continuous process of preparation of plastic material on an extruder, comprising
a housing,

at least two cylindrical housing bores, each housing bore having an axis, said axes being disposed parallel to each other, said housing bores intersecting each other and having a first end and a second end,

an inlet hopper being provided in the vicinity of said housing bores and opening into said housing bores,

a die head being disposed at said second end of said housing bores,

at least a first screw shaft and a second screw shaft being disposed in said at least first and second housing bores,

said at least first and second screw shaft being provided with a first screw and a second screw, respectively, each screw defining a screw root, said first screw and said second screw root tightly intermeshing and said second screw and said first screw root tightly intermeshing,

said first and said second screw each having a screw outer diameter D_a and a screw inner diameter D_i , said screw diameters being identical,

said at least first and second screw shaft each having a volumetric ratio of at least 1.5, wherein the volumetric ratio is defined by the screw outer diameter D_a divided by the screw inner diameter D_i , and

said first and said second axis having a distance a of axes,

a drive connectable to said at least first and second screw shaft to drive said at least first and second screw shaft in a same direction of rotation at a screw speed of rotation n_s and at a shaft torque M_d ,

wherein the method comprises the following steps:

feeding plastic material to be processed through the inlet hopper into said housing bores,

conveying said plastic material through said screw roots from said inlet hopper to said outlet,

driving each of said at least first and said second screw shaft at a screw speed of rotation n_s of at least 600 rpm, at a torque density M_{d/a^3} of at least 11 Nm/cm^3 , wherein the torque density is defined by the shaft torque M_a [Nm] at each first and second shaft divided by the third power of the distance a of the first and second axes of the first and second screw shaft.

7. A method according to claim 6, wherein said at least first and second screw shaft is driven at a screw speed of rotation n_s of at least 800 rpm.

8. A method according to claim 6, wherein the at least first and second screw shaft is driven at a screw speed of rotation n_s of up to 3000 rpm.

9. A method according to claim 6, wherein said at least first and second screw shaft is driven at a torque density M_d/a^3 of up to 15 Nm/cm^3 .
10. A method according to claim 6, wherein the plastic material is conveyed through said housing bores from said inlet hopper to said outlet at a mean product dwell time of less than 10 seconds.
11. A method according to claim 10, wherein the plastic material is conveyed through said housing bores from said inlet hopper to said outlet at a mean product dwell time of less than 2 seconds.
12. A method according to claim 6, wherein in addition to plastic material, pigments are fed into said housing bores.
13. A method according to claim 6, wherein said method is exercised on an extruder having a volumetric ratio of at least 1.55.

3. **In the drawings**

Please accept the proposed drawing change, which is the addition of Figures 3, 4 and 5, submitted under separate cover to the official draftsman.

Applicant respectfully requests approval of the proposed drawing change.

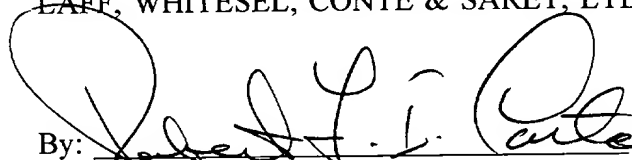
Respectfully submitted,

LAFF, WHITESEL, CONTE & SARET, LTD.

Date:

Mar 22, 1998

By:



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09/043954

Method of Carrying out Continuous Preparation Processes on Tightly Meshing Extruders Rotating in the same Sense

Specification

5

The invention relates to a method of carrying out continuous preparation processes on tightly meshing extruders rotating in the same sense such as twin-screw and multi-shaft screw-type extruders.

- 10 Tightly meshing twin-screw and multi-shaft screw-type extruders rotating in the same direction are used for continuous kneading processes with or without melting. Frequently, continuous degassing, mixing and expanding processes are integrated, too, and there are cases when the extruders are also used for reactions.

15

The products to be processed comprise plastics, resins, liquids, viscoplastic fluids, pulverulent and fibrous additives as well as food compounds. Discharging may take place for instance via filters and molding processes such as pelletization and section extruding.

20

Extruders of the type mentioned at the outset have been known, in which the screw diameter amounts to as much as 340 mm. The throughputs range from 5,000 to 35,000 kg/h at a ratio between the screw outer diameter and screw inner diameter (D_a/D_i) of 1.18 to 1.25 and 1.4 to 1.6, respectively.

25

The ratio between torque and center distance³ of axes (m_d/a^3) - the so-called "torque density" - is in the range of 5 to 10. Depending on the size of the extruders, speeds of rotation are run, ranging from 200 to 500 rpm - in exceptional cases even up to 600 rpm.

Customarily, the design of the extruders is based on the principle of geometric and torque related similarity. Geometric similarity exists when the ratio D_a/D_i is constant; torque related similarity exists when the ratio M_d/a^3 is constant.

In addition to melt temperature and dwell time, the shear rate within the screw root filled with melt is another decisive factor for the dispersing, mixing and homogenization grade of the processed product.

In many processes the mixing, dispersing and homogenization grade will be the higher, the higher the shear rate. In today's state of extruder engineering, mean shear rates in the melting range of between 20 to 150 1/sec and mean product dwell times in the entire screw range of between 15 to 60 sec are customary in standard preparation processes.

In conventional extruders, the mean shear rates are restricted upwards by the screw speed of rotation and the so-called "volumetric ratio" represented by the ratio D_a/D_i . However, increasing shear rates are accompanied with higher specific values of the energy supplied, which may lead to inacceptably high melt temperatures. Together with high average dwell times of the product in the extruder, this may lead to quality reducing deterioration of the product in terms of thermal decomposition and cross-linking.

It is the object of the invention to put into practice quality increasing mean shear rates in the range of up to $\geq 1,000$ 1/sec accompanied with simultaneous reduction of the duration of action of temperature peaks in the product without possible occurrence of the difficulties described above.

This object is attained by the extruder being operated at a screw speed of rotation of at least 800 rpm while the so-called "torque density" (M_d/a^3) which can be induced is simultaneously increased by at least 11 Nm/cm³ and the volumetric ratio (D_a/D_i) is at least 1.5.

With the increased torque density (M_d/a^3) selected according to the invention of at least 11 Nm/cm³, the extruder can easily be operated at the high screw speeds of rotation without any inadmissibly high specific energy input resulting. Another advantage resides in a very high product throughput per time unit.

Suitably, the dwell time of the product in the extruder is less than 10 seconds.

In keeping with another embodiment of the invention, the extruder is operated at a screw speed of rotation of up to 3,000 rpm, while the so-called "torque density" (M_d/a^3) that can be induced is increased by up to 15 Nm/cm³ and the volume ratio is greater than or equal to 1.55 and the mean product dwell time is less than 2 seconds. This will give especially short (mean) dwell times of the product in the extruder as a result of the high throughputs then possible.

The short product dwell times of 1 to 10 sec resulting from the high screw speeds of rotation and the high product throughputs simultaneously reduce the tendency toward thermal decomposition or cross-linking of the products.

Within certain limits, an increase of the screw speed of rotation is also possible without an increase of the torque density (M_d/a^3). However, the maximum screw speed of rotation is limited by the maximum upper limit of specific energy input which exists in every process and corresponds to the maximally permissible melt temperature (without deterioration of the product occurring).

The embodiment according to the invention of the method of the type mentioned at the outset helps open further fields of use.

For instance, the method according to the invention can be used for the continuous masterbatching in the solids conveying range and for the grinding into powder of coarse-grained bulk material. Also, a combination of the two processes mentioned above is conceivable, i.e. a homogenization process of solids, which requires clearly less energy as compared with homogenization in the plastic phase.

Using the method according to the invention in reaction machines will moreover ensure efficient masterbatching of monomers and catalyst prior to the reaction in the incubation period.

Another advantage of the method according to the invention resides in that for instance pigments can be dispersed distinctly better during masterbatching.

In the following, the invention will be explained, based on diagrammatic illustration, in which

Fig. 1 is a representation of the "mean specific energy input",

Fig. 2 is a representation of the "material throughput and mean dwell time of the product in the extruder".

5

Tests based on the method according to the invention were made on commercial two-shaft screw-type machines (two-shaft screw kneaders having tightly meshing screw shafts rotating in the same direction), the structure of the machine (screw geometry, mixing and kneading elements) being left as used so far for the respective plastics preparation process at customary speeds of rotation of 200 to 400 rpm.

In the tests, use was made of screw speeds of rotation by far exceeding 1000 rpm, and surprisingly it was found that upon simultaneous increase of the induced torque density to 11 to 14 Nm/cm³, no substantial increase of material temperature occurred. Even with an increase of the material temperature (for instance PC > 350°C) to some unusually high melt temperature, there is no deterioration of the product, since the dwell times in the extruder are by far less than 10 s due to the method according to the invention.

Fig. 1 diagrammatically illustrates the context between the screw speed of rotation (shear rate) and the specific energy supplied for varying torque densities Md/a^3 . Under the condition that the available torque is utilized, higher throughputs result while torque density increases (at a constant speed of rotation). Noticeably, reduced energy inputs and thus lower melt temperatures result from an increased torque density. On the other hand, an increase of the screw speed of rotation will generally lead also to increased

material throughput, however, at a given torque density, this throughput is connected with an increased energy input.

Fig. 2 illustrates the dependency of throughput and dwell time. It shows
5 that while the throughput increases, the time during which the material is exposed to high temperatures is clearly reduced.

Tests carried out have shown that even a material temperature which, from experience so far, simply had to lead to reduced quality in the product will
10 not mean quality impairment if the time of exposure is sufficiently short. However, sufficiently short dwell times can only be obtained by increased throughputs which, again, can only be realized by an increase of the possible torque, since otherwise, at a given (high) speed of rotation, the driving power of the machine will no longer be sufficient.

15 As can also be seen in Fig. 1, an increase of the speed of rotation within certain limits is possible even without an increase of the torque density. The maximum upper limit, adherent to every method, of specific energy input (e_{specmax} corresponds to the maximally permissible melt temperature
20 without deterioration of the product at a given dwell time) restricts this speed of rotation.

As a rule, today's machines exhibit D_a/D_i values ranging from 1.4 to 1.6 and Md/a^3 values between 5 and 10. Depending on the layout, the operating
25 speeds of rotation range from 200 to 500 rpm, even to 600 rpm in exceptional cases.

The throughput and the quality of the compounded product depend on the screw geometry utilized, on the speed of rotation and the maximum torque of the machine.

- 5 It is the object of every compounding job to obtain a homogenous final product - as a rule by incorporation of additives. The additives and any existing inhomogeneities must be dispersed in the machine and incorporated distributively. Dispersing particles requires more or less elevated shear stresses, which have to be imparted to the particles by way of the surrounding matrix. According to the equation

$$\tau = \eta * \bar{Y} \quad (1)$$

- 15 the shear stress τ results from the viscosity η of the matrix medium and the shear rate \bar{Y} there forced on. Therefore, in addition to the melt temperature and the dwell time, the shear rate \bar{Y} [1/sec] is a decisive factor for the dispersing, mixing and homogenization grade of the processed product in the screw root filled with melt.

- 20 In a simplified consideration of the shear rate as a mean value from the quotient circumferential screw speed/spiral depth, the following applies (provided a 100 % degree of filling in the screw root):

$$\bar{Y} = \frac{v_u}{h} = \frac{D_a * \pi * n_s}{(D_a - D_I) / 2} \quad (2)$$

25

or

$$\bar{Y} = 2\pi * n_s * \frac{(D_a / D_I)}{(D_a / D_I) - 1}$$

The following is true for many processes:

The higher the shear rate, the higher the mixing, dispersing and homogenization grade. With today's state of extruder engineering, mean shear rates in the melt range of 20 1/s to 150 1/s and mean dwell times of the product in the entire screw range of 15 to 60 s are customary in standard preparation processes.

In conventional extruders, the mean shear rates are restricted upwards by the screw speed of rotation and the "volumetric ratio" designated by D_a/D_f as seen from the equation (2).

However, according to the equation

$$\bar{e}_{spec} = \frac{1}{\rho_s} \cdot \bar{\eta}_{(\dot{\gamma})} \cdot \bar{\dot{\gamma}}^2 \cdot \bar{t} \quad (3)$$

15.

and

$$\bar{e}_{spec} = \frac{1}{\rho_s} \cdot \bar{\eta}_{(\dot{\gamma})} \cdot \bar{t} \cdot 4\pi^2 \cdot n_s \cdot \left[\frac{(D_a / D_f)}{(D_a / D_f) - 1} \right]^2$$

20 higher values of specific energy input e_{spec} will result in the case of increasing shear rates, which again may lead to inacceptably high melt temperatures, since the temperature increase of the melt is computed from the equation $\Delta T = e_{spec}/C_P$ (C_P = specific heat capacity). Combined with high average dwell times of the product in the extruder, a high shear rate may
25 also lead to quality reducing deterioration of the product (thermal decomposition or cross-linking).

5

Symbols Used:

	\bar{e}_{spec}	mean specific energy supplied [kWh/kg]
5	\bar{t}	mean dwell time of the product in the extruder [s]
	ρ	melt density [kg/m ³]
	$\bar{\dot{\gamma}}$	mean shear rate [1/sec]
10	$\bar{\eta}$	mean dynamic viscosity [Pa sec]
	D_a	screw outer diameter [mm]
15	D_i	screw inner diameter [mm]
	\bar{h}	spiral depth, mean value
	n_s	screw speed of rotation [min ⁻¹] ([s ⁻¹])
20	M_d	shaft torque, related to 1 shaft [Nm]
	a	center distance of axes of the screw shafts [cm]
25	v_u	circumferential speed of the screw shafts [m/s]
	M_{d/a^3}	torque density, related to 1 shaft [Nm/cm ³]
	$\bar{\tau}$	shear stress [Nm/mm ²]
30	c_p	specific enthalpy [kJ/kg*K]
	m	material throughput [kg/h]
35	ΔT	material temperature increase [K]

Patent Claims

1. A method of carrying out continuous preparation processes on tightly meshing extruders rotating in the same sense such as twin-screw and multi-
5 shaft screw-type extruders, **characterized in that** the extruder is operated at a screw speed of rotation of at least 800 rpm accompanied with a simultaneous increase of the so-called "torque density" (Md/a^3) which can be induced of at least 11 Nm/cm^3 and a volumetric ratio (Da/Di) of at least 1.5.
- 10 2. A method according to claim 1, **characterized in that** the mean product dwell time is less than 10 seconds.
- 15 3. A method according to claim 1, **characterized in that** the extruder is operated at a screw speed of rotation of up to 3000 rpm accompanied with a simultaneous increase of the so-called "torque density" md/a^3 which can be induced of up to 15 Nm/cm^3 and a volumetric ratio (Da/Di) equal to or greater than 1.55 and a mean product dwell time of less than 2 seconds.
- 20 4. Use of the method according to one or several of claims 1 to 3, **characterized in that** the method is used for the continuous mixing in the solid conveying range and/or for the grinding into powder of coarse-grained bulk goods.
- 25 5. Use of the method according to claim 4, **characterized in that** pigments are incorporated during masterbatching.

Abstract

- In a method of carrying out continuous preparation processes on tightly meshing extruders rotating in the same sense such as twin-screw and multi-
5 shaft screw-type extruders, the extruder is operated at a screw speed of rotation of at least 800 rpm, accompanied with a simultaneous increase of the so-called "torque density" (M_d/a^3) of at least 11 Nm/cm³ and a volumetric ratio (D_a/D_i) of at least 1.5.

APPROVED	O.G. FIG.	
BY	CLASS	SUBCLASS
DRAFTSMAN		

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1/2

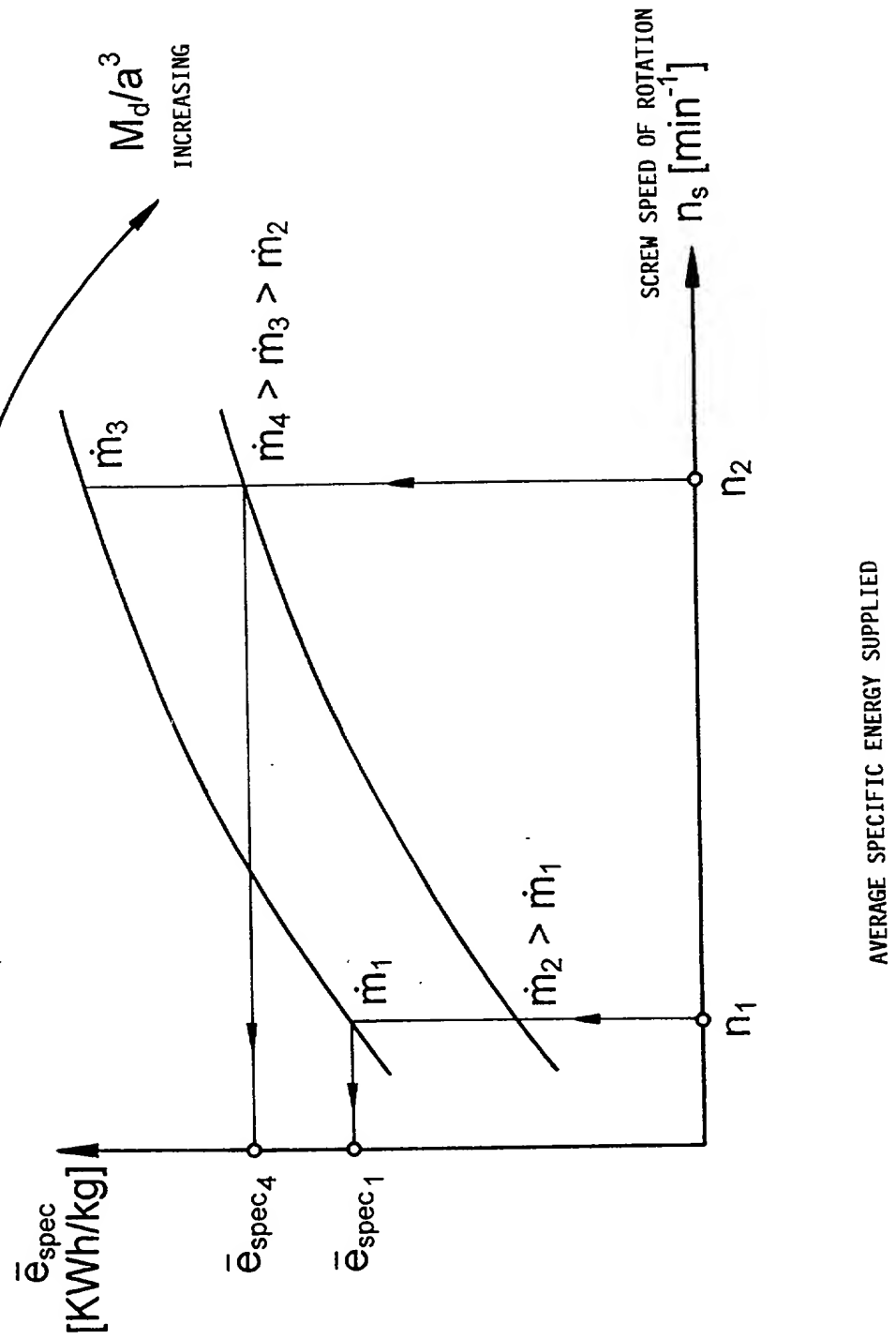
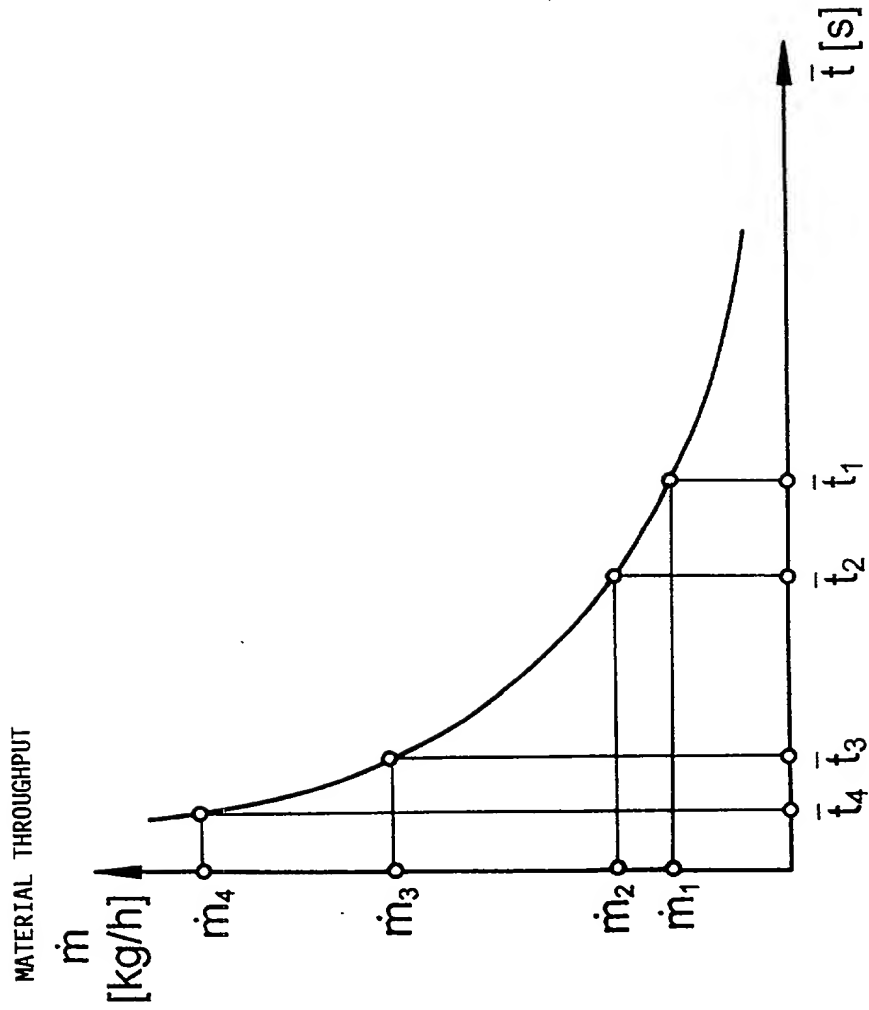


Fig. 1

APPROVED	O.G. FIG.	
BY	CLASS	SUBCLASS
DRAFTSMAN		

09/043954

2/2



AVERAGE DWELL TIME OF THE PRODUCT IN THE EXTRUDER

Fig. 2

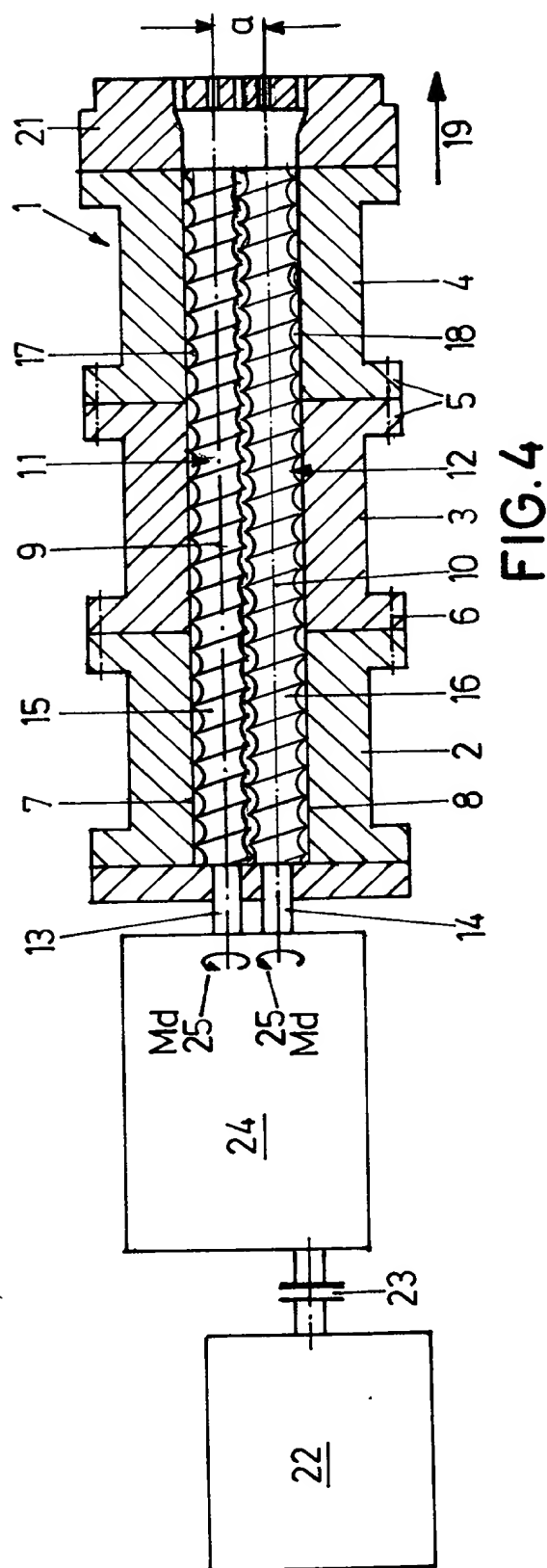
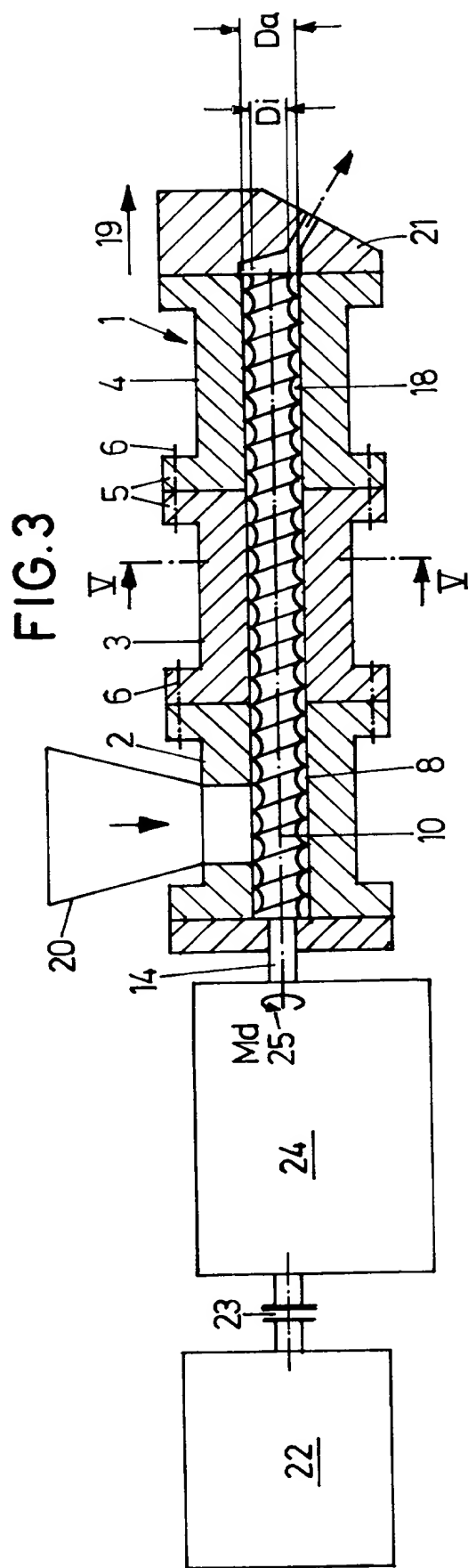
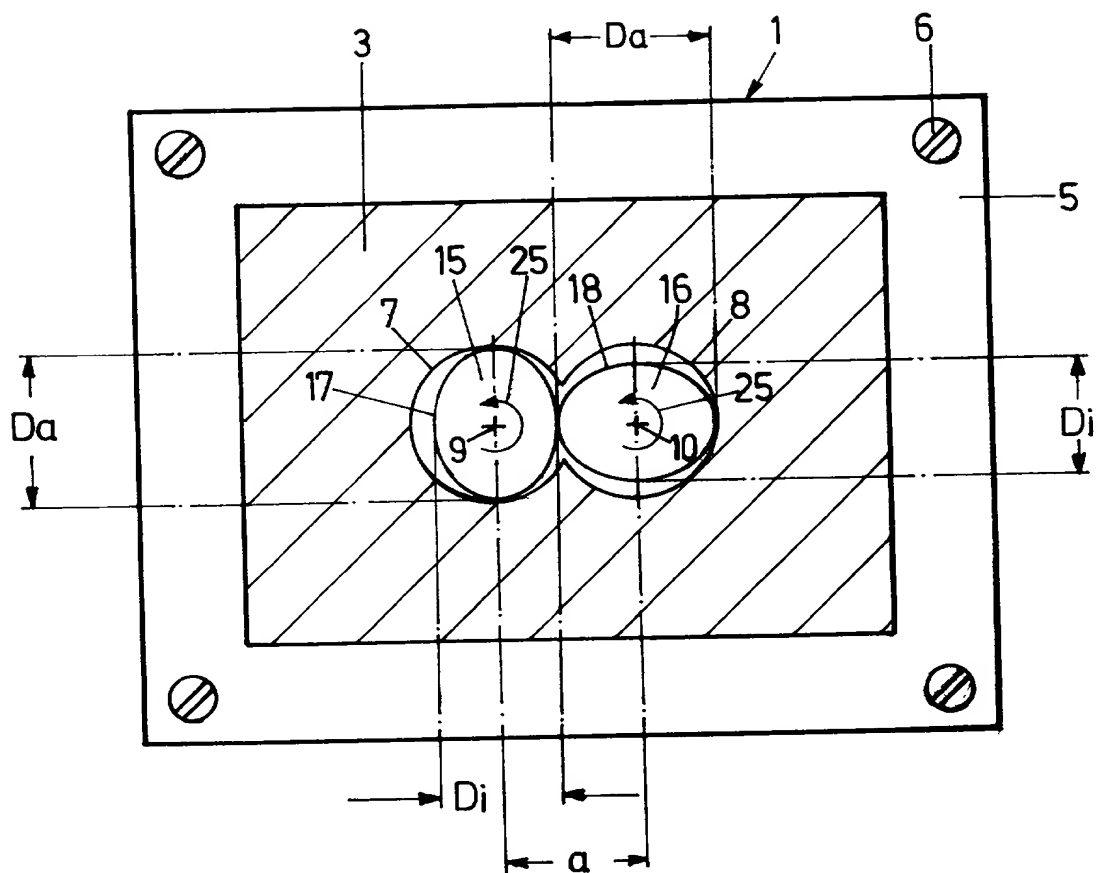


FIG. 5



Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled Method of Carrying out Continuous Preparation Processes on Tightly Meshing Extruders Rotating in the same Sense, the specification of which

(check one)

☒ is attached hereto.

☐ was filed on _____ as
Application Serial No. _____
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
195 36 289.6	Germany	September 29, 1995	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No
(Number)	(Country)	(Day/Month/Year Filed)		
_____	_____	_____	<input type="checkbox"/> Yes	<input type="checkbox"/> No
(Number)	(Country)	(Day/Month/Year Filed)		
_____	_____	_____	<input type="checkbox"/> Yes	<input type="checkbox"/> No
(Number)	(Country)	(Day/Month/Year Filed)		

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

PCT/EP96/03531

August 9, 1996

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

8
POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agents(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. Charles A. Laff (49787); J. Warren Whitesel (16830); Robert F. I. Conte (20354); Larry L. Saret (27674); Martin L. Stern (28911); ~~Bernard L. Weiner (22128)~~; Louis Altman (19373); Barry W. Sufrin (27398); ~~Mark A. Appleton (29607)~~; ~~Jennifer A. Dunner (33885)~~; ~~Thomas J. Donovan (30231)~~; and Jack R. Halvorsen (18394).

Send Correspondence to: LAFF, WHITESEL, CONTE & SARET, 401 North Michigan Avenue, Chicago, Illinois 60611.

Direct Telephone Calls to: _____
at telephone No. (312) 661-2100.

Full name of sole or first inventor	
Dr. Peter HEIDEMEYER	
Inventor's signature	Date
<i>P. Heide Meyer</i>	25. Febr. 1998
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Full name of second joint inventor, if any	
Dipl.-Ing. Erwin HÄRING	
Second Inventor's signature	Date
<i>Erwin Häring</i>	25. Febr. 1998
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Federal Republic of Germany	

(Supply similar information and signature for third and subsequent joint inventors.)

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

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Full name of third inventor third joint inventor	
Dipl.-Ing. Rainer MÜNZ	
Inventor's signature	Date
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Full name of second inventor joint inventor fourth joint inventor	
Dipl.-Ing. Rainer HERTER	
Second Inventor's signature	Date
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Federal Republic of Germany	

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(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Full name of sole or first ^{inventor} fifth joint inventor <u>Dipl. Phys. Ulrich BURKHARDT</u>	
Inventor's signature <u>Ulrich Burkhardt</u>	Date <u>25. Feb. 1998</u>
Residence <u>Stuttgart, Federal Republic of Germany</u>	
Citizenship <u>German</u>	
Post Office Address <u>Theobald-Kerner-Strasse 14. D-70732 Stuttgart</u>	
<u>Federal Republic of Germany</u>	
Full name of second joint inventor, if any	
Second Inventor's signature	Date
Residence	
Citizenship	
Post Office Address	

(Supply similar information and signature for third and subsequent joint inventors.)

09/043554

In Re Application of: Peter Heidemeyer et al.)
)
Case No.: 3210x198) Group Art Unit:
)
Serial No.:)
)
Filed: herewith) Examiner:
)
Title: METHOD OF CARRYING OUT) ATTN: OFFICIAL
CONTINUOUS PREPARATION) DRAFTSPERSON
PROCESS ON TIGHTLY MESHING)
EXTRUDERS ROTATING IN)
THE SAME SENSE)

ATTN: OFFICIAL DRAFTSPERSON
Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

[x] AUTHORIZATION TO PAY AND PETITION FOR THE ACCEPTANCE OF ANY NECESSARY FEES. If any charges or fees must be paid in connection with the following Communication (including but not limited to the payment of issue fees), they may be paid out of our deposit account No. 12-0064. If this payment also requires a Petition, please construe this authorization to pay as the necessary Petition which is required to accompany the payment.

[] Applicant hereby petitions for entry of this Amendment which is mailed within the _____ month after the due date of _____. Enclosed is check No. _____, dated _____, in the amount of \$ _____, as payment of the necessary Petition fee.

PROPOSED DRAWING CHANGE

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first-class mail in an envelope addressed to Assistant Commissioner for Patents, Washington, D.C. 20231 on:

Date: March 27, 1998

By: _____

Signed: _____

LAFF, WHITESEL, CONTE & SARET, LTD.
Attorneys at Law
401 North Michigan Avenue
Chicago, Illinois 60611
(312) 661-2100

REGISTRATION

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John M. England, Jr.	34813
Scott B. Feder	33129
G. Peter Albert, Jr.	37268
Lisa C. Childs	39937
Michael B. Allen	37582
William A. Meunier	41193